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USER INTERFACE FOR REMOTELY MANAGING A FLEET OF MEDICAL DEVICES

ABSTRACT

Jere Laine: User interface for remotely managing a fleet of medical devices
Bachelor of Science Thesis, 26 pages
Tampere University
Bachelor's Degree Programme in Electrical engineering
February 2019

Epilepsy is a chronic disorder characterized by occasions of involuntary movement, also known as seizures. However, effective treatment requires that the seizures can be reliably recorded and accurately classified.

Neuro Event Labs Oy is a start-up developing a video monitoring system for diagnosing nocturnal epilepsy seizures. The system consists of night-vision cameras, and a cloud-based management system. The doctor responsible for treatment can log in to the cloud service, see seizure reports and adjust treatment accordingly.

At the moment there is no system that automatically reports the status, whereabouts or allocation of the remotely installed cameras. The purpose of this thesis is providing the user interface specification and screenshots for a remote monitoring program used by the fleet manager. The human-centered design process is described phase-by-phase. In the last chapter, the final design is presented.

Keywords: User interface, biomedical engineering, epilepsy

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

FOREWORD

First, I would like to give my thanks to Neuro Event Labs Oy who gave me an excellent opportunity to apply my skills on a real-world project that will hopefully save lives and improve the quality of life of people suffering from epilepsy and other such conditions. My special thanks go to Τατιάνα Αναγνωστάκη for sharing her expertise and offering advice.

I would also like to thank my friends and family, especially my father and the one I met on wappu 2017 for their unconditional support.

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LIST OF SYMBOLS AND ABBREVIATIONS

AI	Artificial Intelligence
BIOS	Basic Input/Output System
HDD	Hard disk drive
NEL	Neuro Event Labs Oy
Nelli	Product developed by Neuro Event Labs Oy
SIM	Subscriber identity module
SSH	Secure Shell
UI	User Interface
VEEG	Video Electroencephalogram

1. INTRODUCTION

About 50 million people worldwide have epilepsy. It is a chronic disorder characterized by occasions of involuntary movement, better known as seizures. Even though the cause of epilepsy often remains a mystery, there are excellent treatment paths available [1]. However, effective treatment requires that the seizures can be reliably recorded and accurately classified.

Neuro Event Labs Oy (NEL) is a start-up developing a video monitoring system for diagnosing nocturnal epilepsy seizures. The system consists of night-vision cameras, and a cloud-based management system. The cameras monitor sleeping patients, and the camera control computer sends the video to the cloud service. A self-learning artificial intelligence (AI) then processes the video and detects and classifies seizures. The doctor responsible for treatment can log in to the cloud service, see seizure reports and adjust treatment accordingly.

This system has two main advantages. First, epilepsy patients have traditionally written down their seizures in a diary themselves. This method is not practical for diagnosing nocturnal seizures. Patients and their family have difficulties recognizing seizures or remembering if a seizure has taken place during the night [2]. Often only ~30% of the seizures are reported [3]. Second, the product (Nelli) is more affordable than spending a night in a hospital sleep lab [2]. Additionally, while video electroencephalogram (VEEG) used in sleep labs is a powerful diagnostic tool, patients are unable to stay there for many nights; their quality of sleep may also be different from usual due to the strange environment and the EEG cap they are wearing. The Nelli cameras can remain installed for months next to the patient's bed at home effectively solving both of these issues.

Currently, no system automatically reports the status, whereabouts or allocation of the remotely installed cameras. Thus, the amount of cameras that can be installed at any given time is limited. The purpose of this thesis is providing the user interface (UI) specification and screenshots for a remote monitoring program used by the fleet manager (henceforth referred to as “fleet management UI”).

Chapter 2 covers the users and context of the fleet management UI along with the hardware restrictions. Chapter 3 describes how the design process took place and what decisions were made. Chapter 4 covers the final design.

2. USERS AND CONTEXT

2.1. Users

The primary user for the fleet management system is known as a "fleet manager." The role is highly specialized, and the system can be designed accordingly. However, one of the goals of developing the fleet management UI is making it usable for more people. One person can make mistakes, but if the system has multiple users, the mistakes are significantly more likely to be detected. The fleet manager is a trained professional, whose responsibilities include ensuring the device fleet is always operating at optimum capacity. Due to the nature of the fleet manager's role, there is a high likelihood for the fleet manager being male [4]. Since men only have one X chromosome, about 8% of men have a genetic red-green color vision defect [5]. This has to be taken into account in the design of the UI. The fleet manager is not expected to have any other disabilities.

The status of the devices is monitored every day. In the future, even around-the-clock monitoring is not inconceivable. Therefore, routine tasks should be designed to be as effortless as possible. All relevant information should also be readily visible, since having to look for it behind menus is likely to cause frustration when performing routine tasks [6]. Frustration leads to sloppiness, which is something to be avoided when managing a medical device.

The following persona was created for design purposes.

Maikki - Fleet manager

- 31 years old
- Prefers the command line to graphical user interfaces
- Always very busy with work
- Values time and gets irritated when time is wasted
- Gets irritated when the network is down

Pain points:

- Currently manual work
- Easy to make mistakes
- Does everything alone, which is risky
- Knowing what devices need updates

Overall goals:

- Save time
- Avoid mistakes

2.2. Tasks

Based on several face-to-face and chat interviews with the current fleet manager, the user does not need to manipulate data all that much. Instead, the primary focus is on viewing information from the remotely installed camera devices. This is done to ensure that the devices work properly and the number of active devices is as high as possible. Devices idling in a warehouse do not generate revenue for the company.

As a fleet manager I want to:

- See the hostname of the device. This is simply a human-readable name, making the device easy for me to identify.
- See the network quality (upload speed). This determines how well the device is able to upload monitoring data to the cloud service. With offline or low-bandwidth installations the device has to be accessed manually by a technician when the hard disk (HDD) becomes full.
- See the external IP addresses of the devices. Knowing the IP address allows me to access the device for diagnosis and repair purposes remotely.
- Connect to the device using secure shell (SSH). This allows me to remotely issue commands to the device and is the main way of fixing problems when they occur.
- See how much HDD space is available. A full disk may lead to the device becoming unresponsive.

- See software version information. Devices receive updates fairly often, and knowing version information is helpful when I'm diagnosing issues.
- See the "stage" of the software (TAYS, HUS and so forth). This indicates which hospital or facility is using the device. It also tells me who the customer is.
- See the status of critical processes on the device. If one of these processes fails, the device no longer works properly and I need to take action to fix it. Seeing the status of individual processes helps me to determine what component is broken or what is needed to make the device operational again.
- See where all active devices are currently located. Some devices can be on the other side of the globe. Location on a map is helpful when I'm deciding which technician is commanded to perform maintenance on a device. It also looks very impressive, and is excellent marketing material.
- See how many devices are active, in maintenance, et cetera. This information is helpful when I'm planning near-future monitoring periods.
- See the physical addresses of the devices. This information is necessary when I'm scheduling maintenance or pick-up trips.
- See the ID of the patient who is being monitored. Names are unnecessary and potentially a security risk, but if someone reports a problem, that device is easier to find on the device list if the patient ID is available. It may also be helpful in cases in which the patient has a tendency to break devices.
- See installation and pick-up dates. This information is necessary when I'm scheduling future monitoring periods and installation/pick-up routes.
- See Basic Input/Output System (BIOS) version. The camera device contains a computer that receives BIOS updates. Updating the BIOS is sometimes necessary for newly developed updates to work. On the other hand, BIOS updates can also cause malfunctions or even "brick" the device entirely. Therefore, BIOS version information is useful when diagnosing issues.
- See SIM card serial number. The devices have SIM cards and they use mobile data networks to send patient recordings to the cloud service. Serial number information is helpful especially when the device has been stolen: I can use it to tell the operator which internet plan to cancel.

- See and edit notes. There may be device information that is difficult to express otherwise. It is relevant for me to know details such as that the camera computer has no lid and is currently on the test engineer's desk waiting for someone to investigate the coil whine it makes.
- Change the device status manually. The device status is intended to change automatically. In case of a malfunction, I must be able to change it manually.

2.3. Context of use

According to interviews conducted, the fleet management UI will be used mainly in an open-plan office. Ideally, the fleet management UI would always be visible on a giant screen on the wall. According to observations, however, the system is more likely to reside in an always-open browser tab on the fleet manager's computer.

The environment can be stressful due to tight deadlines. Also, open-plan offices have received criticism due to high noise levels [7]. Therefore, it is preferable if the UI does not rely on auditory feedback.

Control panels designed to show large amounts of information at a glance are known to be impractical or even dangerous in hectic environments. An outstanding example of this is the Three Mile Island nuclear accident in 1979. Several factors, including the incredibly complex control panels (Fig. 1) caused a reactor core meltdown which is still considered to be the worst nuclear accident on American soil. Complexity presents a design challenge, as one of the requirements is to design a system where everything is visible at a glance.

The fleet management UI is designed to manage medical devices. Extra care must be taken when processing patient data, and the system should not show any sensitive information that is not necessary. Reliability is also of paramount importance. Reliability concerns are, however, alleviated by the fact that the system is mostly automatic and even if something goes wrong, the worst expected outcome is the loss of a single patient's data; no one gets injured.

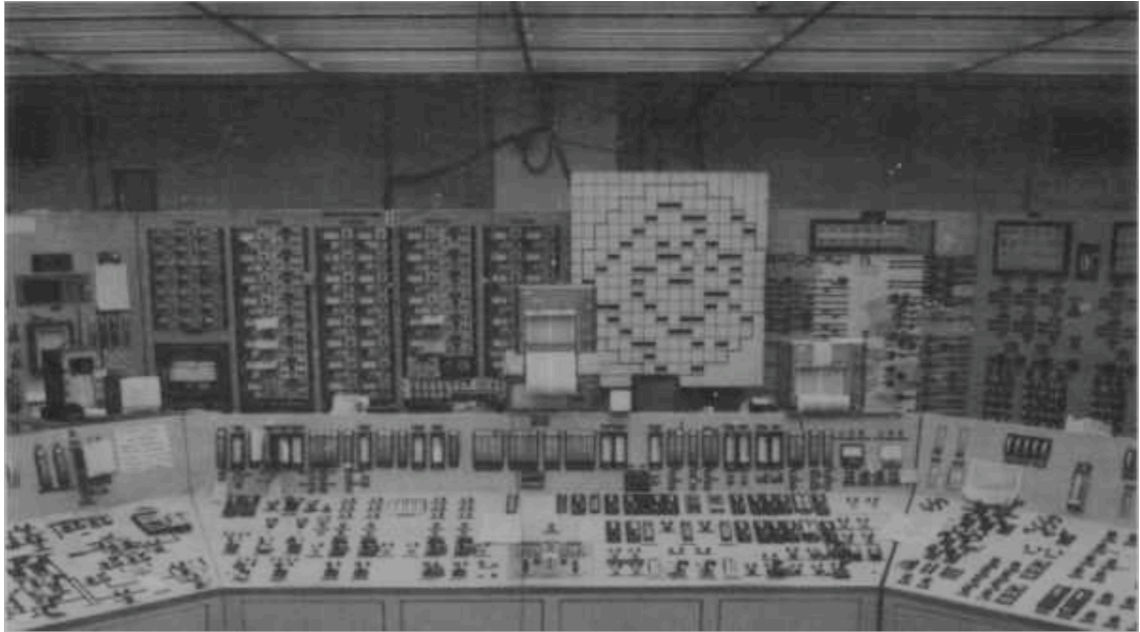


Fig. 1: Three Mile Island nuclear plant control room [8]

2.4. HARDWARE

It should be possible to implement the fleet management UI as a web application written using the Angular web framework. The reason for this is the general reluctance to tie the software to a specific computer. It may also be necessary to access the UI while away from the office to confirm that the devices are working correctly. The reasoning behind using Angular is the fact that all other Nelli user interfaces have been developed using Angular, and the expertise required to use the framework is already in the company.

As the fleet manager stated in the interviews conducted, under ideal circumstances the UI is always visible on a large screen on a wall. Based on the observations of the office environment this is not likely to happen, but in any case, the system will be used on a large screen. This screen will have Full HD (1080x1920 pixels) or better resolution, QHD (2560x1440 pixels) screens not being uncommon. The UI will be controlled with a mouse and a keyboard. No touch screen or mobile implementations are planned at this time. Feedback should be purely visual as haptic interfaces have poor availability and support and auditory feedback may cause dissatisfaction in an office that is noisy to begin with. There are no notable performance or power limitations.

3. DESIGN PROCESS

After the extensive background work described in chapter 2, it was time to start on the actual design. Inspiration was found by looking at the already-implemented parts of the Nelli dashboard, especially the doctor's view. Considering that companies want to brand their items to make themselves more memorable, it was a natural choice to use the colors, fonts and design language already present in these designs. The spreadsheet currently used for fleet management (Fig. 2) was also a valuable asset.

When a doctor logs into the cloud to view patient information, he sees a list of patients, (Fig. 3). From this view, he can navigate to the patient view (Fig. 4) to view seizure data and perform tasks such as downloading a pdf report and watching videos of recorded seizures. These views served as a basis for the design language used.

Henceforth, all pages with screenshots have a dark background to provide better contrast and a view that is less stressful to the eyes. For optimal experience, please ensure your screen is appropriately calibrated before viewing the screenshots.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD		
1	Check daily at 11:00 that recording is as expected If yes: Add your silables to the devices row on each day. If not: Log the actions needed below During weekends no need to do if not separately agreed for special follow up.																															
2																																
3																																
4	DEVICE	STAGE	SIM	LID	LTS	GIT - enc	GIT - url	SLIM	default json	NOTES	P-ID	Monitoring time	June 14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
5	OCELOT	TAYS	21170789679678	X	X		X				245	15.6.-13.7.									HE	KH	KH	KH	KH		HE	HE	HE			
6	JAGUAR	TAYS	21170230432589	OLD			X		X		126	6.6.-4.7.									HE	KH	KH		KH	KH		HE	HE	HE		
7	SERVAL	TAYS	21170234861783	X	X	X	X				178	4.7.-1.8.																				
8	MARGAY	TAYS	21170467826887	X	X	X	X				87	29.6.-27.7.																				
9	CHEETAH	TAYS	21160798235436	X	X	X	X			Bad connection qu	14	20.6.-18.7.									HE	KH	KH	KH	KH	KH		HE	HE	HE		
10	ONCILLA	TAYS	21170234767283	X	X	X	X			Coilwine																						
11	LEOPARD	TAYS / NEKU		-	X	X	X	X																								
12	PUMA*	dev	-	-	-																											
13	TIGER*	dev	21170342544365	-	X					John / i7 / 32 Gb																						
14	LION	TAYS		-						Parkinson																						
15	LYNX	TAYS / SL		-			X			i5 - has special stuff, do not touch																						
16	CARACAL*	dev	-	-	-					John / i7 / 32 Gb																						
17	KODKOD	HUS	21170384573984	OLD			X			Room 7																						
18	COLOCOLO	HUS	21170238427355	-			X			Room 9, WD HD + extra HD																						
19	PANTHER	HUS		-			X			Room 8																						
20	SPHYNX*	dev	21160237678357	-	-					Jane / barebone																						
21	TACOCAT*	dev	-	-	-			X		18-model																						
22	YOSHI*	dev	-	-	-			X		18-model																						
23	SMILODON	TAYS	21170328964298	X	X	X	X	X																								
24	BENGAL	HUS		X				X		reserved HUS																						
25	MARLOT	HUS		X				X		reserved HUS																						
26	CATAMOUNT	HUS		X				X		reserved HUS																						
27	COUGAR	TYKS		X				X		reserved turku																						
28	FOFFI IS	dev																														

Fig. 2: Fleet management spreadsheet

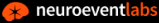
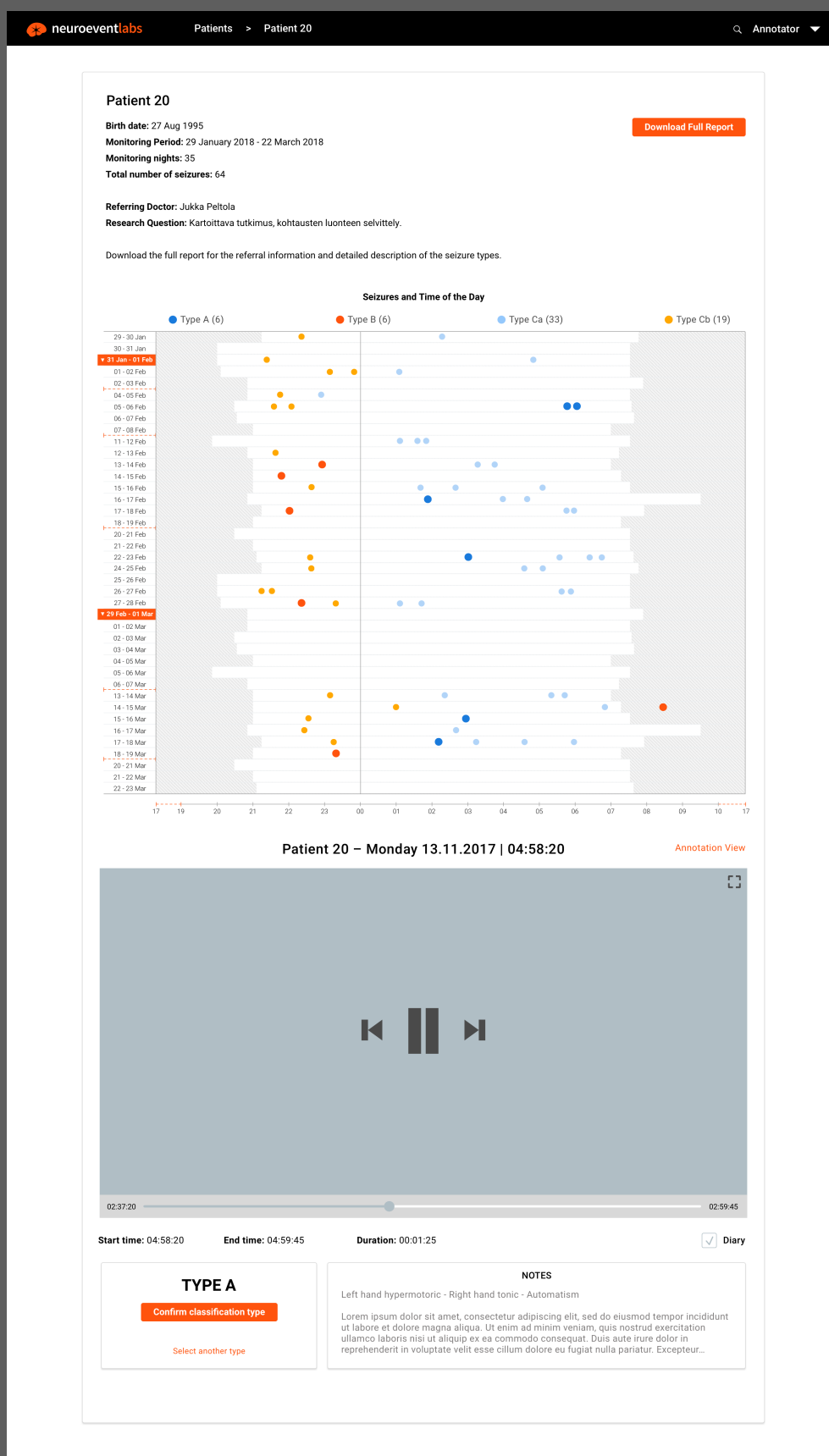
<div>  <div>Interactive Reports</div> <div>Jere Laine ▼</div> </div>				
Interactive Reports				
Family name	Given name	Birthdate	Period	Report
Schnakenhals	Hans	20 Aug 1991	01 Jan 2018 - 30 Jan 2018	<div>Open</div> <div>PDF</div>
Schnakenhals	Hans	20 Aug 1991	01 Jan 2018 - 30 Jan 2018	<div>Open</div>
Schnakenhals	Hans	20 Aug 1991	01 Jan 2018 - 30 Jan 2018	
Tosteson	Celestyn Liana	01 Jun 1999	29 Jan 2018 - 06 Mar 2018	<div>Open</div>

Fig. 3: Patient list view



3.1. Navigation model

The navigation model of the system changed several times over the course of the project. For the sake of clarity, diagrams were created to visualize the model. Fig. 5 represents the first map. The diagram here is known as a DoGo-map: it describes what the user can do and where the user can go from each view. They are similar to mind maps in appearance and function. Input fields are also listed on these diagrams.

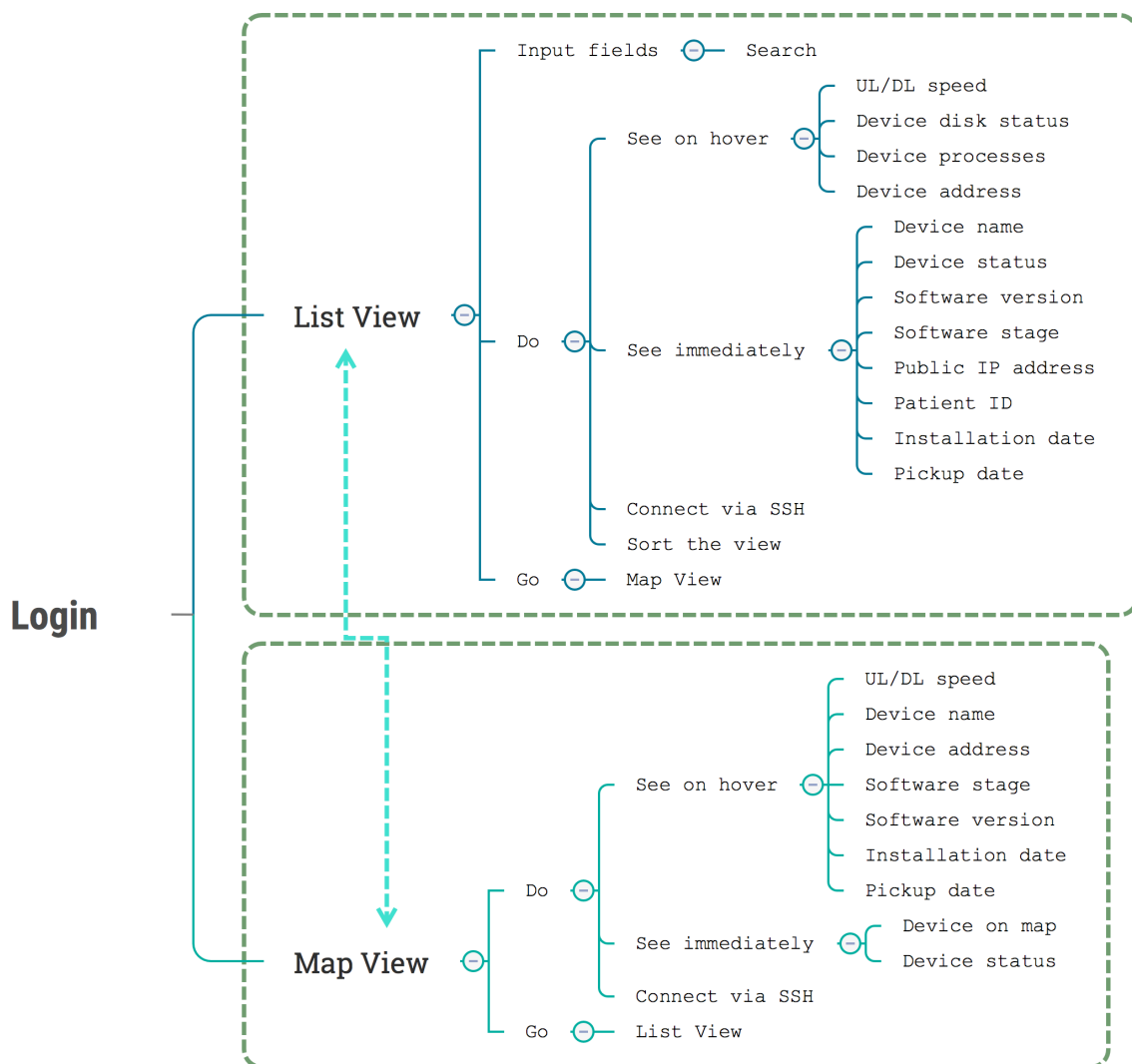


Fig. 5: First DoGo-map

3.2. Wireframes

At first, the decision was made to have two views: a device list and a map view. The first-ever design can be seen in fig. 6. It is worth noting that when compared to the usual definition for a wireframe these designs are quite detailed, maybe even too detailed considering the early stage of the design. It has a sortable list of devices that closely resembles the patient list. It also has placeholder buttons for the following (from left to right):

- Device address (hovering over this shows address, a click takes the user to the map)
- HDD status (hover shows disk status),
- Network status (hover shows accurate upload/download speeds)
- SSH button (click connects via SSH)
- Status indicated by color: green for idle, blue for recording, red for error and purple for maintenance.

In fig. 7 this design had evolved somewhat based on feedback from the fleet manager. It no longer shows the IP address since they are pseudo-randomly generated, and thus the list does not have to be sorted based on the IP. Instead, the installation/pickup dates have been added to the list separately, because sorting by these attributes is essential. Some of the tooltips are also visible, but it is worth noting that in the actual program only one would be visible at any given time. Fig. 8 is a partial screenshot of the design, showing the tooltip that includes the status of critical processes.

3.3. Color design

Designing the colors for the fleet management UI was reasonably straightforward since previous designs had already defined the color palette. Black text and white background make the text easy to read. Orange (#FF530D) is a company color and stands out as a highlight color. The navbar is black just as in previous designs, and while it may look good in some other color as well, there is still little reason to change it. Device status indicator color changed with the design, though: at first, a green indicator meant that the device is idle and available in the company warehouse. Blue meant that the device is installed and working as intended. These were later reversed due to feedback. It makes more sense that the green color is reserved for devices that work correctly, and blue is for devices "sleeping" in the warehouse. Other

neuroeventlabs Device List Map View

Devices

Name	Stage	Version	Patient ↑	Period	Network	Status
CHEETAH	Tays	v1.02	--	--	--	
LEOPARD	Tays	v1.00	NCC-1701	12.3.18-30.4.18	80.192.20.133	
TIGER	Tays	v1.04	NCC-1701	12.12.18-11.10.19	144.67.28.123	
PUMA	Hus	v1.02	NCC-1701	1.8.18-1.9.18	255.156.8.4	
LION	Hus	v1.02	NCC-1701	1.10.18-1.11.18	67.234.567.9	

Fig. 6: First design

neuroeventlabs Device List Map View

Devices

Name	Stage	Version	Patient ↑	Monitoring	Installed	Status
CHEETAH	Tays	v1.02	--			
LEOPARD	Tays	v1.00	31	12.3.18-30.4.18	12.3.18-30.4.18	
TIGER	Tays	v1.04	32	12.12.18-11.10.19	12.12.18-11.10.19	
PUMA	Hus	v1.02	45	1.8.18-1.9.18	1.8.18-1.9.18	
LION	Hus	v1.02	48	1.10.18-1.11.18	1.10.18-1.11.18	
SEA LION	Hus	v1.04	66	5.6.18-1.9.18	1.6.18-1.9.18	

Fig. 7: Early design with tooltips

Devices

Name	Stage	Version	Patient ↑	Installation	Pickup	Status
CHEETAH	Tays	v1.02	--			
LEOPARD	Tays	v1.00	31	12.03.18	30.04.18	
TIGER	Tays	v1.04	32	12.12.18	11.10.19	
PUMA	Hus	v1.02	45	01.08.18	01.09.18	
LION	Hus	v1.02	48	01.10.18	01.11.18	

Status: MONITORING

- process1 WAITING
- process2 RUNNING
- process3 RUNNING
- process4 RUNNING
- process5 RUNNING
- process6 STOPPED

Fig. 8: Early design with status tooltip

colors for status indicators include dark orange for malfunctioning devices (strong color, indicates the need for attention), purple for devices in maintenance (no symbolic connection, but easy to recognize) and yellow (universal symbol for warnings but not as strong as orange).

3.4. Icon design

The fleet management UI has icons for device status, network status, and address. There is also an icon for editing notes and status. The first designs had placeholder icons, later more specific designs were added. The first status icons used color to convey the status of the system, but due to color blindness concerns the icons were later redesigned. The network indicator also saw radical changes. The first version was just a crude placeholder. The staff frequently mocked the second version calling it a "volleyball" or some other piece of sports equipment. The location icon remained roughly the same after the first version; only the gray background was replaced with a shadow due to aesthetic reasons and to make the icon look more like a button [9].

All the icons were designed to follow the same visual guidelines, namely in detail color (white) and line width. The symbols were also carefully considered to make them easy to recognize [10]. In the final version, the icons for location and network are standardized, which makes them easy to identify. Status icons have a cross on a red background, an exclamation sign on yellow and a check mark on a green background. These symbols are self-explanatory. It took significantly more effort to decide what icon to use for stored devices or devices in maintenance. The first maintenance icon was a hammer. The hammer, too, was made fun of, usually with remarks concerning communism. It was then replaced with a wrench. The original icon for idling devices was \emptyset , similar to the empty group symbol used in mathematics. It was found to be too unclear and was replaced with a small house symbolizing home. The meaning of this icon is clear, but only further testing reveals whether or not it is too detailed to be seen clearly.

3.5. Overall design

After receiving feedback from the initial wireframes, the icons received a significant overhaul. Their number was reduced from 5 to 3 to reduce clutter and add negative space to the UI, and they were completely redesigned. Hovering the cursor over the location marker showed the address of the device while clicking took the user to the map. Hovering over the network icon (the infamous "volleyball") showed detailed connection information. Clicking the icon established the SSH connection. HDD status was moved to the status

icon tooltip. An omnibox-style search bar was added in case the user needs to filter the list based on the device hostname or some other attribute (Fig. 9). Another notable upgrade was reordering the list so that the devices with errors are always on top of the list. This version also features a “teal” device state indicating that the device is not currently used, but it has been allocated for use in near future. Later it became evident that the devices are not allocated beforehand, and the state was removed.

The first map view (Fig. 10) was also designed at roughly this time. It featured location markers that expanded once hovered over to show more detailed information about the device. The color of the location marker indicates the status of the device. Clicking the status indicator on the expanded location marker takes the user to the device list and highlights the device in question. Shortly after the network/SSH button was added to this view (Fig. 11).

After a comprehensive feedback session with the staff, it was decided that a timeline view would be beneficial for the user. After all, even the old Google sheet had a timeline. The first timeline prototype (Fig. 12) only showed the name of the device and the state it was in on any given date. It also has a frame around it to make it more consistent with the doctor's view (Fig. 4).

This prototype was soon deemed to be extremely unpleasing to the eye. Beautiful design should be embraced, because, pretty user interfaces are perceived to be easier to use than ugly ones even if the actual operational logic remains the same [11].

Another problem with the timeline that came up during the feedback session was the use of color as a system status indicator. Use of color as the only signifier is not practical due to color blindness concerns. The second version of the timeline (Fig. 13) showed significantly less information focusing only on error history and device allocation. Additionally, patient ID was added together with relevant time-related information such as the month and the year. The vertical grey pipe is always on the current date.

Status indicators on the device list were also redesigned to address color blindness concerns (Fig. 14). Exclamation mark on yellow was added to symbolize a state where the device has a bad network connection and its status cannot be verified.

neuroeventlabs Device List Map View

Devices

Name	Stage	Version	Patient ↑	Installation	Pickup	Address	Network	Status
LION	Hus	v1.02	48	01.10.18	01.11.18			
CHEETAH	Tays	v1.02	--	--	--			
LEOPARD	Tays	v1.00	--	--	--			
PANTHER	Tays	v1.04	31	24.06.18	30.06.18			
TIGER	Tays	v1.04	32	12.12.18	11.10.19			
PUMA	Hus	v1.02	45	01.08.18	01.09.18			
SEA LION	Hus	v1.04	66	05.06.18	01.09.18			

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Fig. 9: First major upgrade

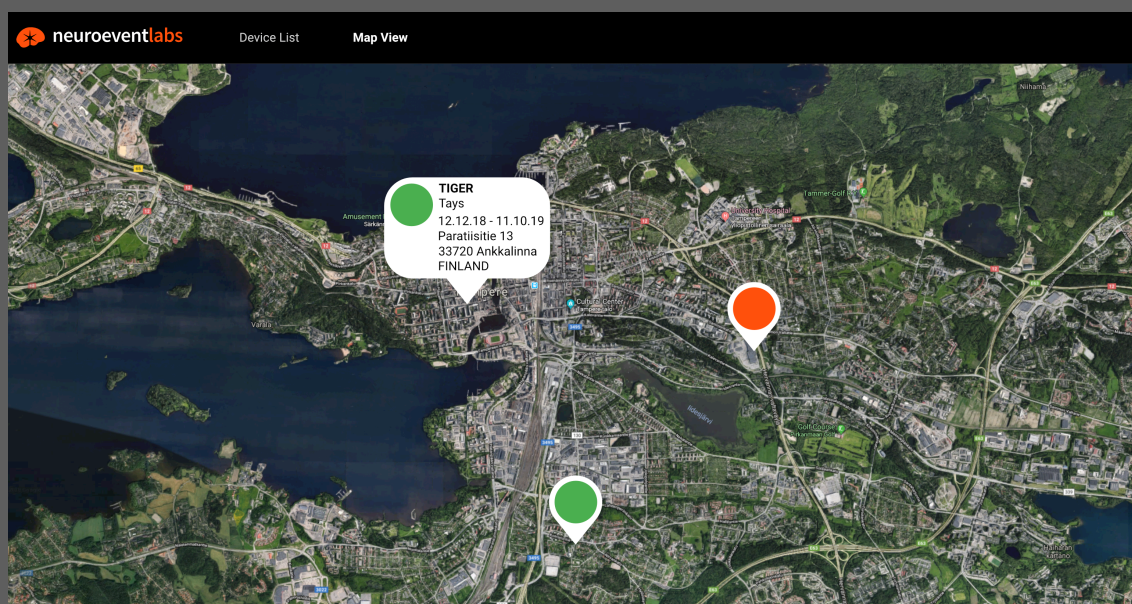


Fig. 10: First map view



Fig. 11: Partial map view with a SSH button

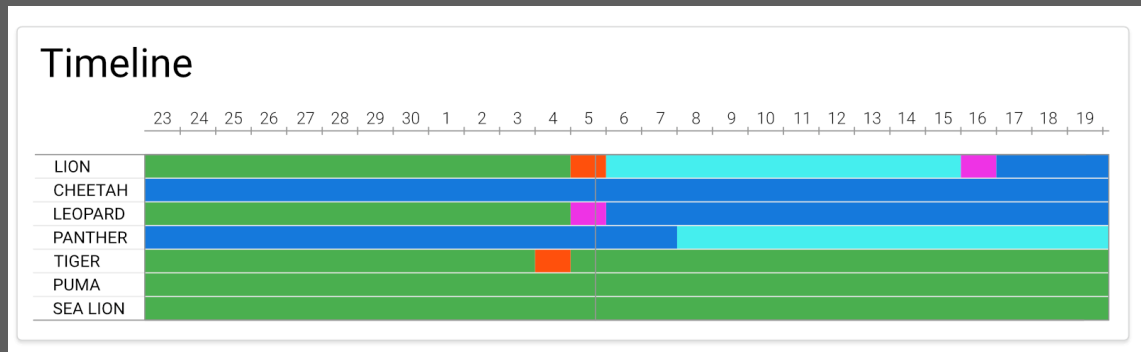


Fig. 12: First (partial) timeline view

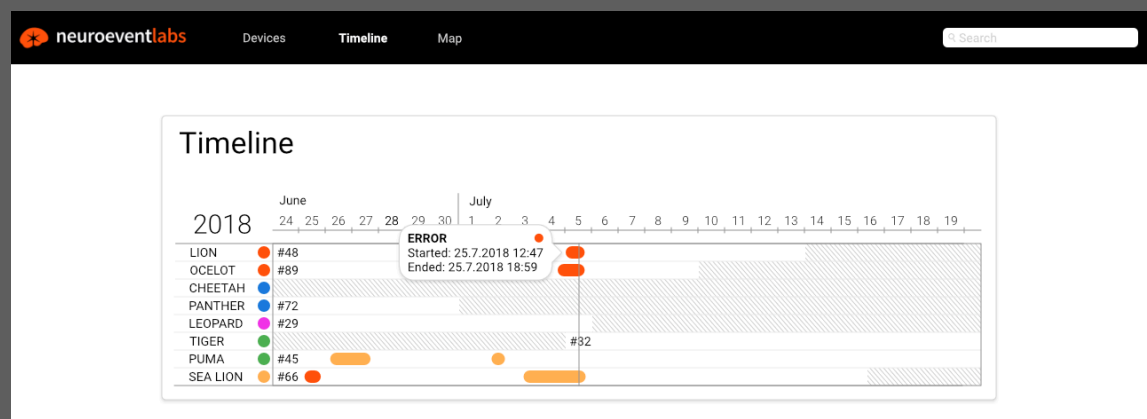


Fig. 13: Significantly improved timeline view with a tooltip

Devices

Name	Stage	Version	Patient †	Installation	Pickup	Address	Network	Status
LION	Hus	v1.02	48	01.10.18	01.11.18			
OCELOT	Tays	v1.02	89	01.12.18	01.13.18			
CHEETAH	Tays	v1.02	--	--	--			
PANTHER	Tays	v1.04	--	--	--			
LEOPARD	Tays	v1.00	--	--	--			
TIGER	Tays	v1.04	32	12.12.18	11.10.19			
PUMA	Hus	v1.02	45	01.08.18	01.09.18			
SEA LION	Hus	v1.04	66	05.06.18	01.09.18			

Fig. 14: List view with detailed status indicator icons

4. FINAL DESIGN

At the time, the designs shown before were considered to be final. A video prototype was created and shown at a design meeting. Overall feedback was very positive. Yet I realized that there were several major problems with the design: First, the information displayed by the timeline partially overlapped with the information on the list. Sorting the devices on the timeline view was impossible or limited. Moreover, the UI did not utilize screen space very effectively because it was designed for screens that have the width of 1280px, not 1920px as it should have been. I had previously assumed that it could just be scaled to Full HD, but this is not the case. Everything on these two views was scrapped and redesigned. The map view remained mostly unchanged until the end.

4.1. Final navigation model

The new design required a new DoGo-map and one was created. It can be seen in fig. 15. While it does not have a branch structure similar to the first DoGo map (fig. 2.) it is identical in function. It lists the different views and what the user can do and where the user can go from them. Input fields are also listed.

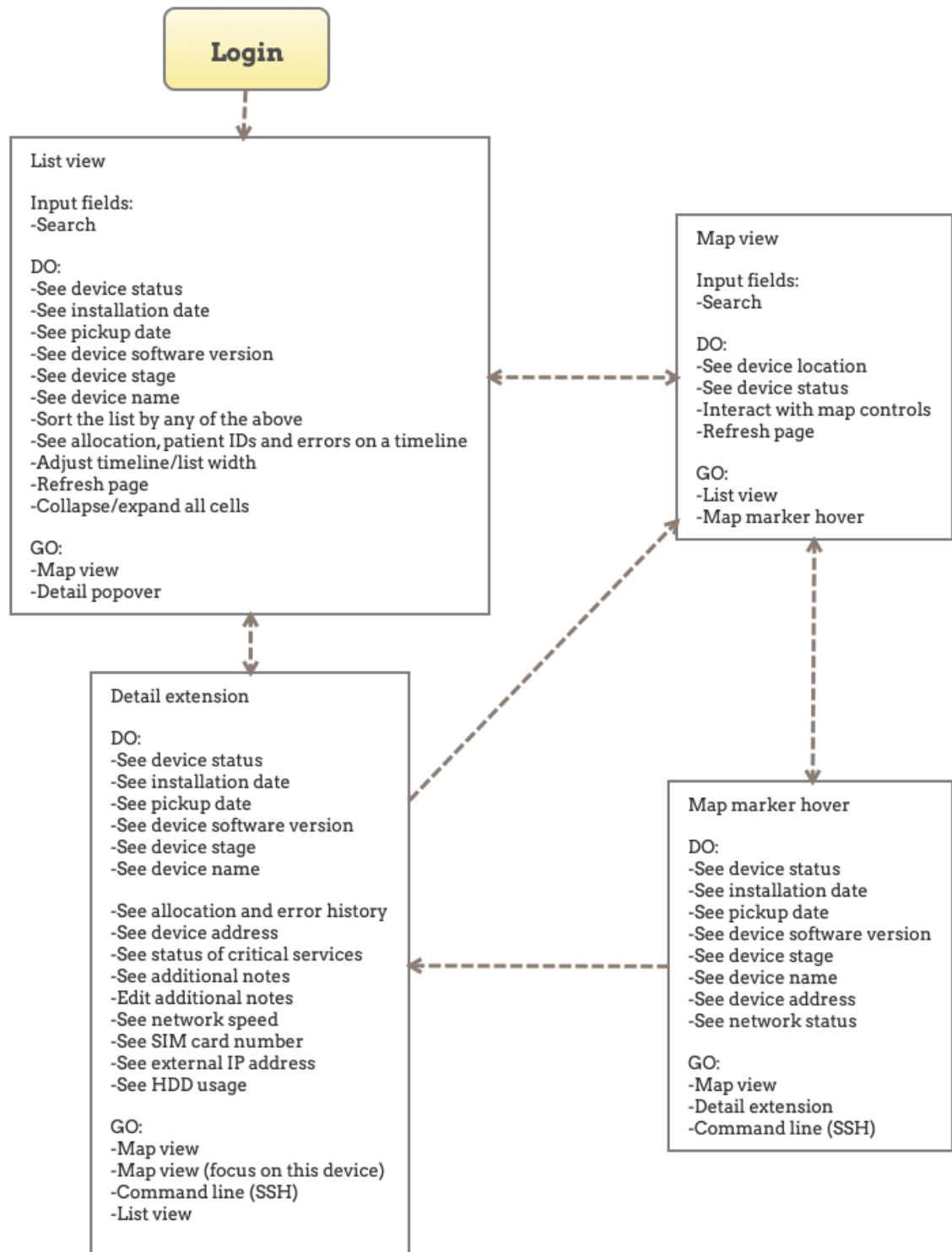


Fig. 15: Final DoGo-map

4.2. Overall design

One piece of feedback that was received earlier in the design process was that the number of hover effects in the system was excessive: copy-pasting the address of a device would surely be extremely annoying if not flat-out impossible if it was only displayed on a tooltip. This was not considered to be very relevant at the time since only one test user mentioned it. However, this redesign was an excellent opportunity to get rid of them, and the decision was made to implement this change.

In the new version (Fig. 16), the timeline and device views have been combined into one. The new design features much smaller margins on all sides. Status indicators and other buttons have received a background shadow that indicates that they are clickable. Weekends are highlighted on the timeline. Patient ID was removed from the device list because they are pseudo-random and therefore sorting the list by the patient ID is useless. The ID's are shown on the timeline instead. The timeline can be scrolled and dragged up and down, in which case the list scrolls with it. It can also be scrolled and dragged sideways.

The most important feature of this new list view is scaling the content. The user can drag the line between the list and the timeline, and their sizes will be adjusted accordingly. By dragging all the way to either left or right, one of the views can even be hidden entirely (Fig. 17) if the user wants to focus on either.

The tooltips were replaced with list cells that expand when clicked (Fig. 18). The new expandable cell contains a significant portion of the information that was previously directly visible to the user. Even though the buttons have been moved here, their function remains the same. Clicking on the cell expands it. Clicking again collapses it. Several cells can be in the expanded state at any given time. Once the cell is expanded, the corresponding timeline cell is also expanded for the sake of consistency. If a part of the information on the cell is hidden due to the timeline, the information can be shown by scrolling or dragging sideways on the cell.

First, the cell has the address of the device and a button to take the user to the map view. Viewing the device on the map is useful, but most likely not something the fleet manager has to do every day.

Next, there is the network indicator. Network status is in-depth knowledge since the status indicator turns yellow if there something wrong with the network. Clicking the network indicator to establish an SSH connection is most likely not going to happen unless there is something wrong with the device, and for this, the user has to know what processes do not work.

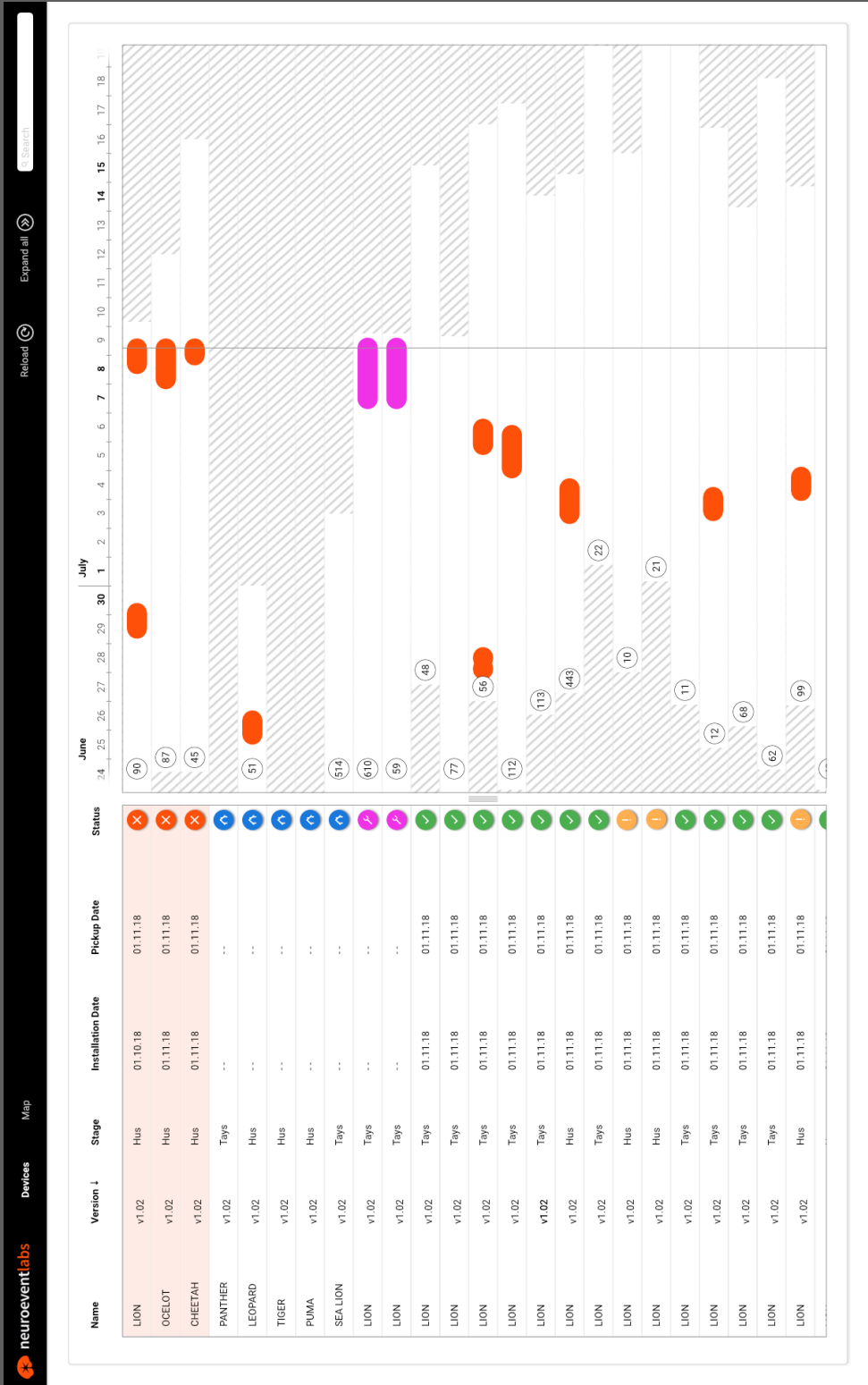


Fig. 16: Final device view design

Devices

Map

Search

Reload

Expand all

Name	Version	Stage	Installation Date	Pickup Date	Status
LION	v1.02	Hus	01.10.18	01.11.18	✗
OCELOT	v1.02	Hus	01.11.18	01.11.18	✗
CHEETAH	v1.02	Hus	01.11.18	01.11.18	✗
PANTHER	v1.02	Tays	--	--	✓
LEOPARD	v1.02	Hus	--	--	✓
TIGER	v1.02	Hus	--	--	✓
PUMA	v1.02	Hus	--	--	✓
SEA LION	v1.02	Tays	--	--	✓
LION	v1.02	Tays	--	--	✓
LION	v1.02	Tays	--	--	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Hus	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Hus	01.11.18	01.11.18	✗
LION	v1.02	Hus	01.11.18	01.11.18	✗
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Tays	01.11.18	01.11.18	✓
LION	v1.02	Hus	01.11.18	01.11.18	✗

Fig. 17: Final device view design - list fully expanded

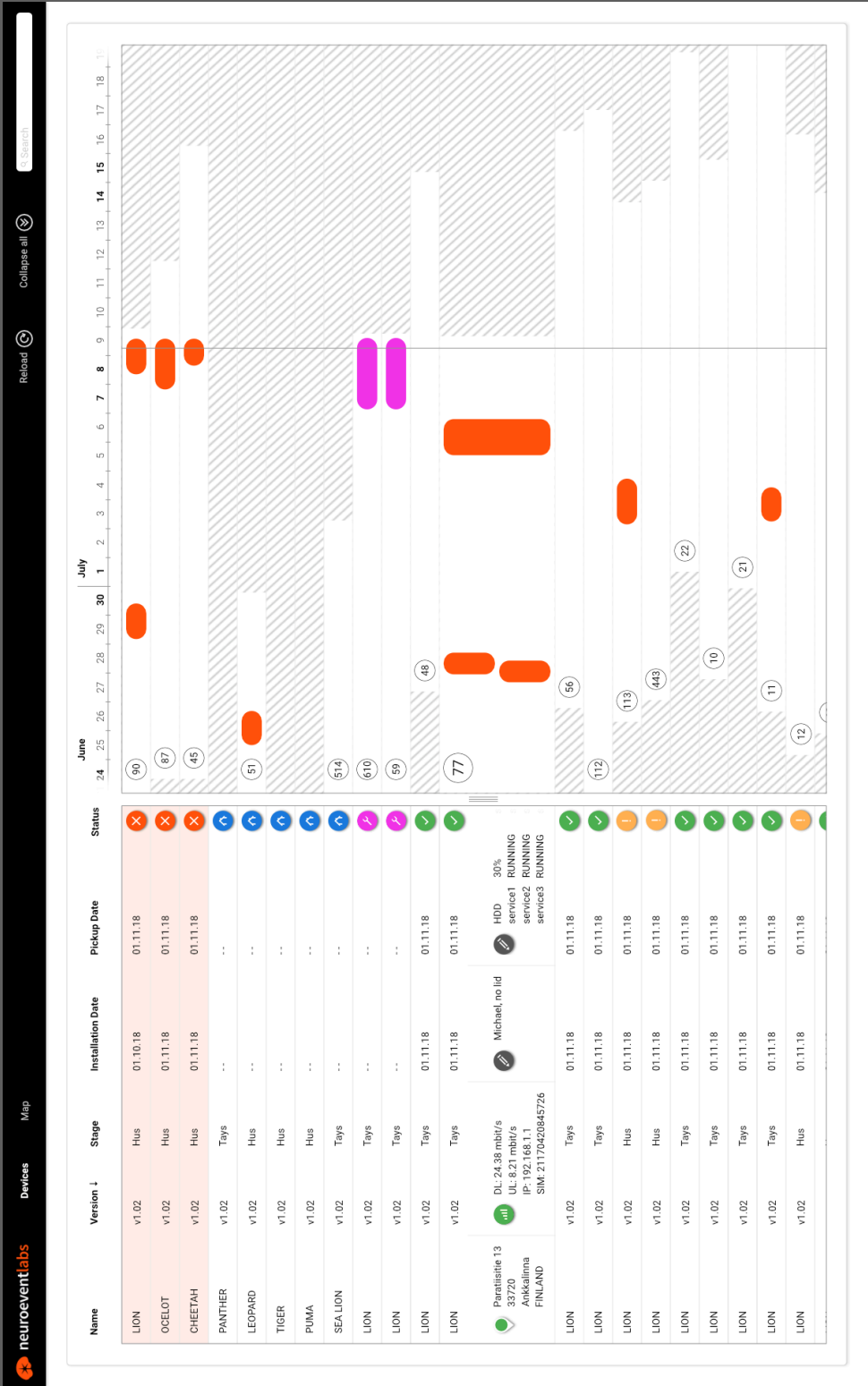


Fig. 18: Final device view design - expanded cell

The notes are also located here. Clicking the button with the pencil icon causes the notes to become editable. Clicking it again saves edits.

Last, there is a process status list that works the same as the tooltip did before. However, now the status of the device can be overridden manually by clicking the pencil. Manual status changes can be useful if the automated system does not turn out to be 100% reliable.

Another detail that was added at this point was highlighting dates. Once the user hovers over any date, a vertical column (Fig. 19) appears that highlights the date. The column makes analyzing the points of the timeline that are farthest away from the dates on top much easier.

Finally, the navbar now contains buttons for collapsing/expanding all cells to make managing the list more convenient. It also has a button for manual reloads in case the system does not reload automatically.

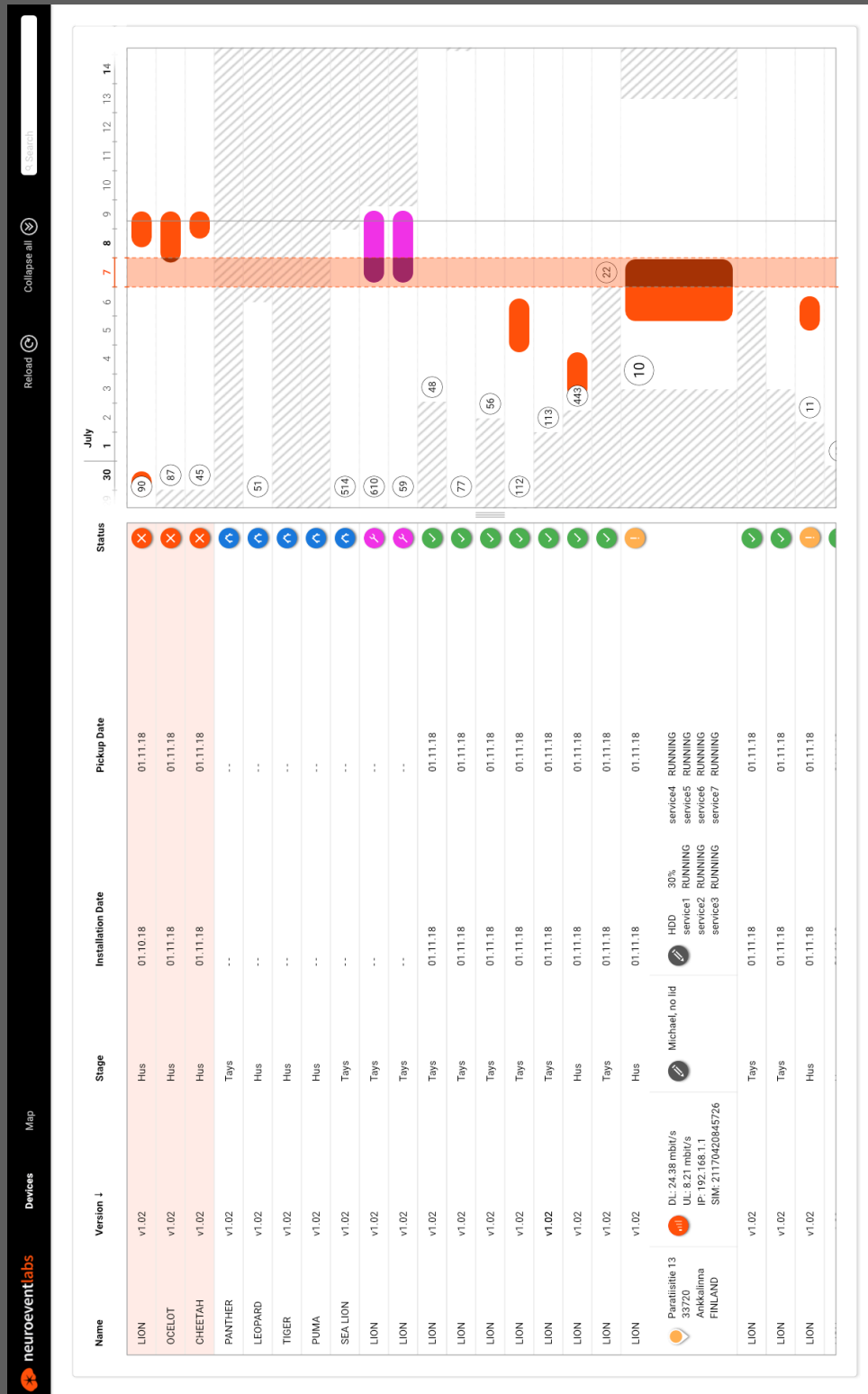


Fig. 19: Final device view design - expanded cell, highlighted column

5. CONCLUSION

Neuro Event Labs Oy is a company developing a video monitoring system for diagnosing nocturnal epilepsy seizures. There is currently no system for remotely monitoring the status of the installed cameras. The purpose of this thesis was designing the user interface for such a system.

The first part of this thesis describes who the users of the system are (the fleet managers) and the multitude of goals they want to accomplish when using the system. The context of use was also explained: a busy open-plan office.

The next part describes the hardware (and software) limitations of the system. The limitations provide some (although minor) constraints for the user interface. At this point, it was concluded that the fleet management UI would be a web application used with a keyboard and mouse.

The last parts focus on how the design process took place. First, the design language used was demonstrated. The language borrows heavily from existing designs to provide a sensation of continuity. From these, prototypes and wireframes were created. The evolution from a 2-view model to a 3-view model and back to a 2-view model is described, as well as the reasoning behind the smaller decisions such as color and icon design. The final design features a device list with an expandable timeline and a view that shows the location of devices on a map. All of the designs were based on user requirements and feedback. The result is a clean and at least theoretically functional user interface.

In retrospect the design process was fluent and the result successful. However, the original low-fidelity wireframes and prototypes were not exactly low-fidelity. In the future, it may be preferable to start with lower-end sketches to avoid unnecessary work.

The next step in design is making a working prototype or an interactive mockup and testing the system in actual working conditions and further improving the system based on feedback. User interface design is a continuous process, and this is certainly not the end of the journey.

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